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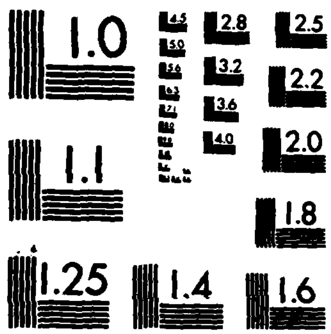

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1983 MARGINAL ICE ZONE EXPERIMENT
Part I: Ice Characterization Measurements
Part II: Helicopter-Borne and
Ship-Based Radar Backscatter Measurement
of Sea Ice in the Marginal Ice Zone

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1983 MARGINAL ICE ZONE EXPERIMENT
Part I: Ice Characterization Measurements
Part II: Helicopter-Borne and Ship-Based Radar Backscatter Measurement of Sea Ice in the Marginal Ice Zone

Robert G. Onstott

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PART I:

ICE CHARACTERIZATION MEASUREMENTS

ABSTRACT

A series of sensor-oriented characterization measurements in support of the experiment's remote sensing efforts from the Polarbjorn ice strengthened ship during the 1983 Marginal Ice Zone Experiment were conducted. Measurements describe the physical properties of the ice in this region and are reported herein. Descriptions include: ice and snow thickness; ice salinity profiles; air, ice and snow temperatures; the construction of the snow pack; and general comments about floe topography.

INTRODUCTION

Sensor-oriented characterizations were performed to support the University of Kansas helicopter-borne and ship-borne scatterometers whose objective was to acquire backscatter data needed to provide descriptions of the scattering coefficients of sea ice in the marginal ice zone. The characterization measurements documented the investigated ice sites and described the physical properties of the ice sheet and snow pack at the time of backscatter measurements. They are also important in that they are used to classify the scene viewed by the near-surface radar and in the study of the active-and-passive microwave interaction process. Both the characterization and scattering property measurements support the airborne remote sensing efforts by assisting in the interpretation and calibration of these data products.

EXPERIMENT DESCRIPTION

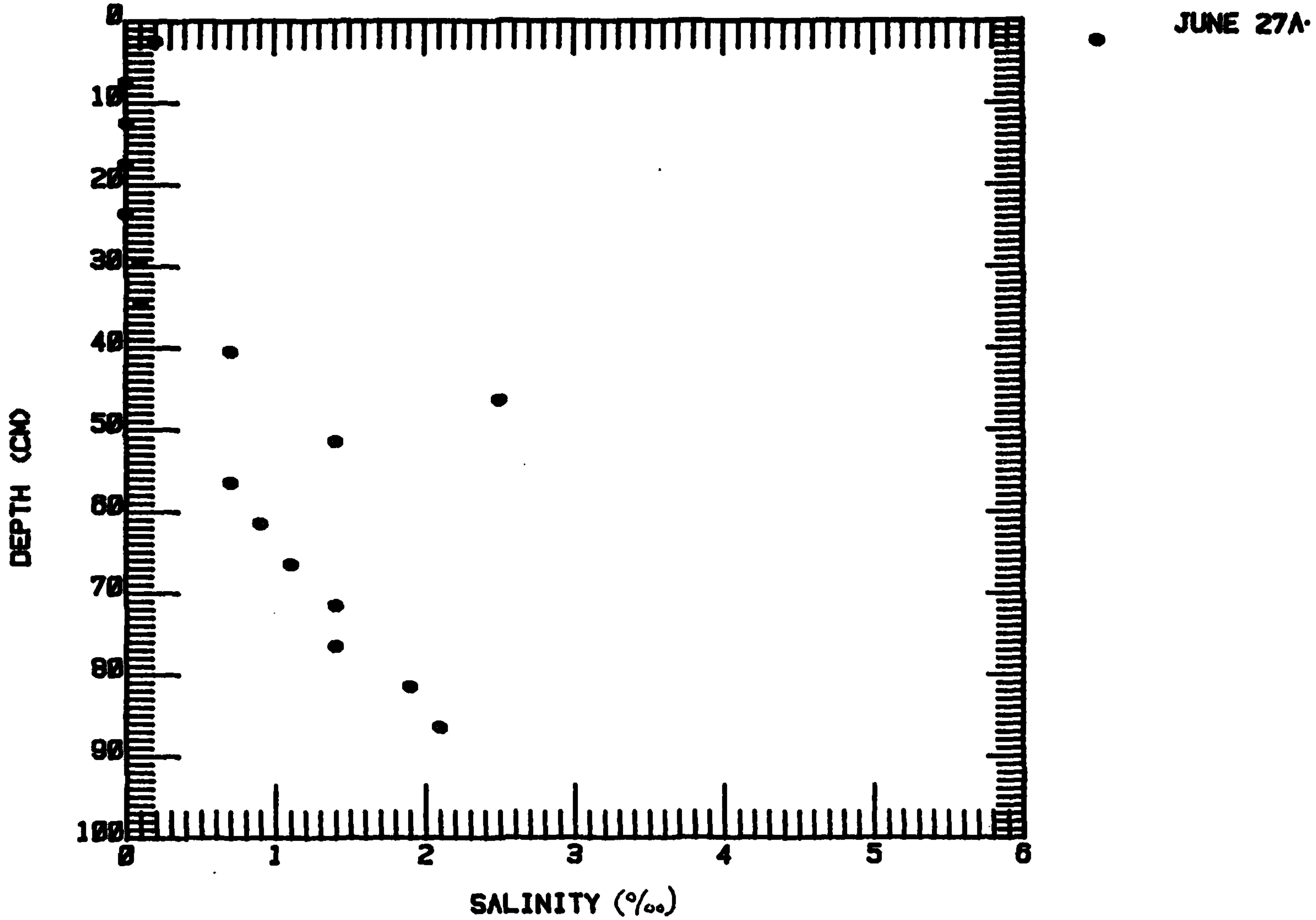
Characterization measurements began June 22 and extended through July 26. Ice sheets were classified according to type (which may change upon more detailed examination of the salinity profiles), thickness, average snow depth,

a description of the physical properties of the snow pack, and of the state of melt. Geographical location, time of day and air temperatures were also recorded. Ice surface and snow temperatures were measured and were typically at 0° C throughout the duration of the experiment. Air temperatures in the margin fluctuated very few degrees from 0° C. Many of the sites that were characterized were also investigated with the ship-mounted scatterometer. The sites observed on July 1 were located adjacent to the Polarbjorn and were selected because they were representative of the major types of ice present in the region about the drift station.

Date/Site	Type - Depth (m)	Average Snow Depth -cm-	T_{AIR} -°C-	Location	Time (NST)	Comments
June 22-A	Shorefast FY-1.4	20	6.1	Fjord of Spitzbergen		Snow layer was composed of large crystals. First 10 cm had 2.5 mm dia. crystals. Next 2 cm was an ice layer, bottom 8 cm had 5 mm dia crystals.
June 24-B	FY-2.0	50	1.6	80° 38.60N 04 08.20E	1408	Floe deformation would be described as wrenched.
June 24-D	FY - 1		0.0	80° 43.68N 14 45.34E	1600	Snow cover had melted leaving mound-like ice features.
June 25-A	FY - 1	30	0.7	80° 51.46N 05 25.86E	0210	Floes in this field had diameters of about 25 m, were mostly undisturbed, but with some blocks and ridges at their edges.
June 25-B	FY	40	1.2	80° 52.26N 05 33.53E	1340	Rain has increased the wetness of the snowpack.
June 26-A	FY	50	2.8	81° 04.59N 05 29.22E	0100	Deformed FY with lots of strewn blocks. Snow cover ranged from 25-100 cm. Snow crystals were wet and 3 mm in dia. Top 2 cm of snowpack froze at end of day. Water had accumulated at snow-ice interface and saturated the top of the ice sheet with fresh water.
June 27-B	MY-4	30	-0.4	81° 03.44N 06 06.47E	1500	Moist firn layer was composed of 3-4 mm dia. crystals. Density reported (by T.G.) to be .4 gm/cm^3. Snow and ice surface temperatures were 0° C. Floe had a 1 m high by 2 m wide ridge line and snow meadows of 30-50 cm depths with no standing water. Ice cores J27A and J27B were retrieved from a bare ice area and a snow meadow, respectively.
June 28-A to July 1-A	MY > 3	15	0.0	81° 01.39N 05 47.78E	1230	Drift Station: During this period established meltpools grew and new meltpools formed under the snowpack and in depressions. Snow was wet and saturated with depths ranging from 6-50 cm. The ice surface was flooded with water and was rotten. A knife blade was easily inserted up to its 6 inch length. Ridge lines ran through the floe. The ablation rate for the snow was 2-3 cm/day. In areas of typical snowpack, crystal diameters in the top 9 cm were 1-2 mm and in the bottom 5 cm were 5 mm. Ice core JY1A was taken from an area of flat ice.
July 1-B	TFY-1.8		-0.6	Drift Station	1230	Floe, located adjacent to the ship, had a visible blue cast, was covered by a 1.5 cm firn layer composed of 3 mm dia. crystals, had a few 30 cm high hummocks and was spotted with meltpools. Freeboard was 8.5 cm. Ice core JY1B was retrieved.
July 1-C	TFY-1.9	10	-0.6	Drift Station	1630	Floe, located directly ahead of the ship, had a visible grey cast, an ice surface which was smooth and a snow cover which ranged from 2-15 cm. Pooling was taking place under the snow pack. An area which did not have surface flooding had an ice layer composed of ball bearing like nodules. Ice core JY1C was retrieved. This core was unusual in that it had 3-5 mm bubbles in the top 10 cm and 3 mm dia. bubbles in the layer from 10-40 cm. The heaviest concentration occurred from 10-20 cm. Remainder of the core was milky in appearance. Freeboard was 25 cm.

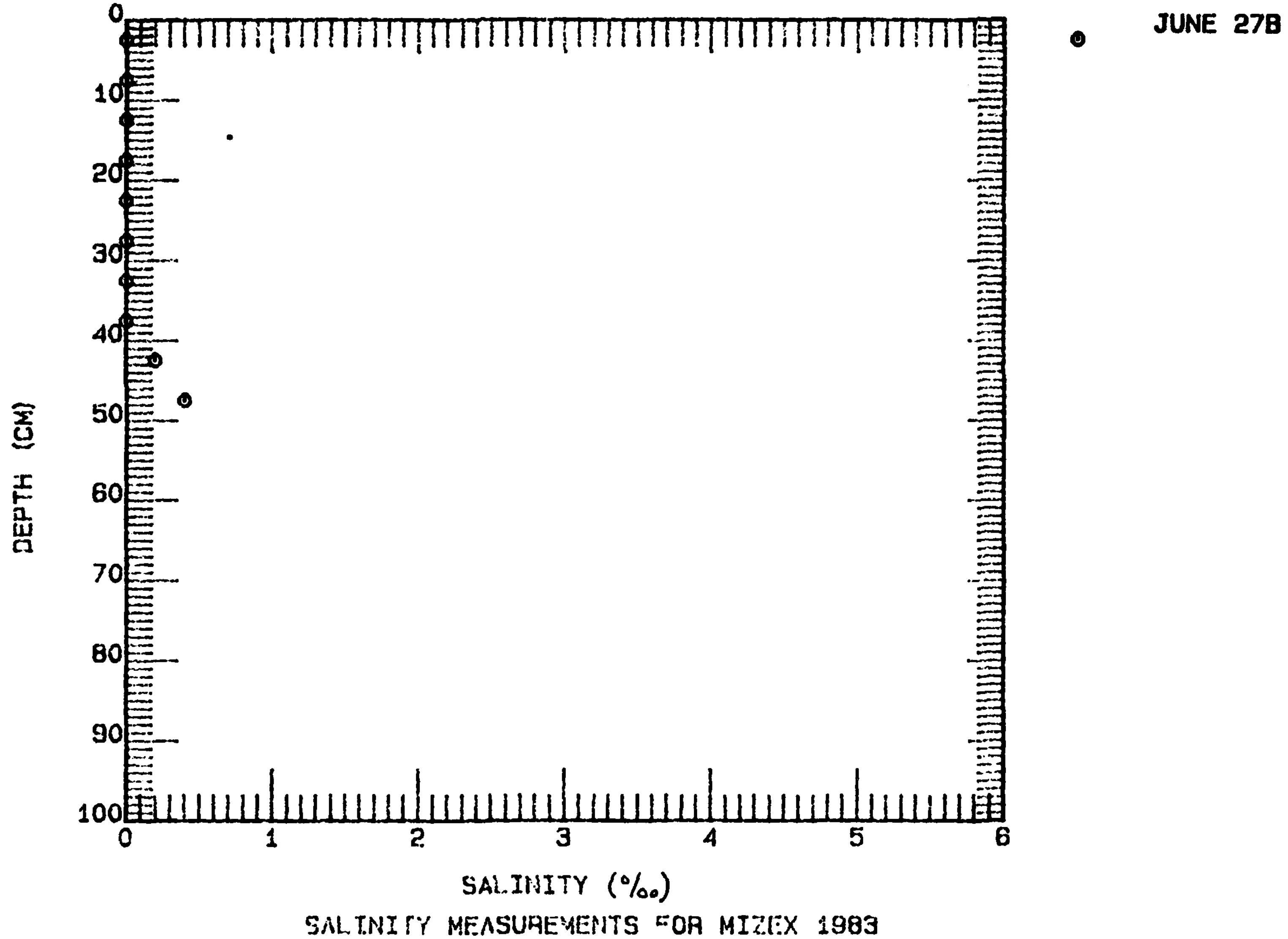
Date/Site	Type Depth (m)	Average Snow Depth -cm-	T_{AIR} -°C-	Location	Time (NST)	Comments
July 1-D	FY-.64	---	-0.6	Drift Station		Floe, located adjacent to the ship, had a smooth ice surface and was covered by a 2 cm crust-like umbrella layer composed of 3 mm dia. crystals. Pooling was taking place. Two depths were taken 10 m apart. Depth 1 = .66 m with a freeboard of 8 cm and Depth 2 = .62 with a free-board of 5 cm.
July 6-A	MY Composite			81° 32.0N 06° 51.2E		This was the "12 Mile Floe" and was photographed extensively.
July 11-A	MY			79° 40.1N 02° 18.68E		In vicinity of Polar Stern. B = 160° R = 1.24 nm
-B	TFY			79° 39.2N 02° 18.95E		B = 153° R = 1.86 nm
-C	FY			79° 39.82N 02° 19.57E		Grey Blue with Crust and MP B = 153° R = 2.04 nm
-D	FY			79° 39.73N 02° 19.95E		Blue FY B = 229° R = 2.51 nm
-E	MY			79° 39.43N 02° 21.42E		FB = 40 cm. No ridging. Firn uniform. B = 300° R = 1.50 nm
-F	FY			79° 39.65N 02° 21.86E		B = 110° R = .27 nm
-G	TFY			79° 39.65N 02° 21.86E		B = 111° R = .27 nm
-H	FY			79° 39.62N 02° 21.96E		Grey B = 138° R = .10 nm
-I	Thin FY			79° 39.38N 02° 22.04E		Interesting patterns - river-like B = 154° R = 4.18 nm
-J	Thin FY			79° 39.3N 02° 21.8E		B = 106° R = 5.50 nm
July 14-A	MY-3.5	40		79° 19.59N 01° 54.65E	GMT 0930	The 45 m and 60 m floe was heavily deformed and contained large tilted blocks with many small to moderately sized pressure ridges. There was a new 15 m long, 3 m high ridge at edge of floe. Floe had well defined meltponds. Snow depths ranged from 2 to 60 cm. Snow in the meltpools had a depth of 26 cm, with the bottom 15 cm water saturated. Free boards ranged from 20 to 70 cm. Ice core JY14A was retrieved. Free board at this location for flat ice was 31.5 cm. Areas which were free of typical snowpack were covered by an ice structure composed of 6.5 cm vertical crystal growths.
July 15-A	TFY-1.79	---		79° 11.76N 03° 05.26E	0400	This 40 m dia. floe located at the leading edge of the ice zone had a bluish cast, was covered by a uniform 2-4 cm crust. Floe had a slight rolling appearance upon close inspection and one melt pool. Ice thickness in the rolling region was 3.56 m with a 9 cm freeboard. Ice thickness in a flat ice zone was 1.79 m with a freeboard of 25 cm. Ice core JY20A was retrieved.
July 20-A	TFY-1.5	30	0		0230	Freeboard was 10 cm.
July 20-B	TFY-2.2	25	0.3	79° 52.46N 01° 52.30E 78° 58.46 01° 52.30W	0700	Moderately deformed TFY with a greenish cast. Melting was at a stage similar to that found for eastern region floes just prior to the drift station (June 26) indicating a lag in the melt cycle. The snow was composed of wet 2-3 mm dia. crystals with some inclusion of 5 mm dia. nodules on certain parts of the floe. Snow cover ranged from 2-35 cm.

Date/Site	Type Depth (m)	Average Snow Depth -cm-	T_{AIR} -°C-	Location	Time (NST)	Comments
July 21-A	TFY-2.40			Adj. to 20B	0130	Floe had a bluish cast, 2 cm of firn, and a fre-board of 18 cm. Ice core JY21A was retrieved.
July 22-A	MY-3.15	4	0.9	Adj. to 21A	1030	Floe had a uniformly distributed firn layer of 2-6 cm composed of 2-3 mm dia. crystals with some areas having .5 cm nodules well defined and a few well eroded meltpools. The lone ridge had a height of 1.5 m. Free board was 10 cm at a low spot and 18 cm most other places. Ice core JY22A was retrieved.
July 19-A	TFY		-0.6	78° 54.06N 03° 01.93E	GMT 0300	Floe had a visible greenish cast, a uniform firn layer and a few meltpools.
July 26-A	TFY			79° 10.12N 03° 03.32E		Floe was in an area of low ice concentration. Snow samples were acquired at 2, 14 and 22 m from the edge of this 60 m dia. floe. It produced salinities of 0°/..

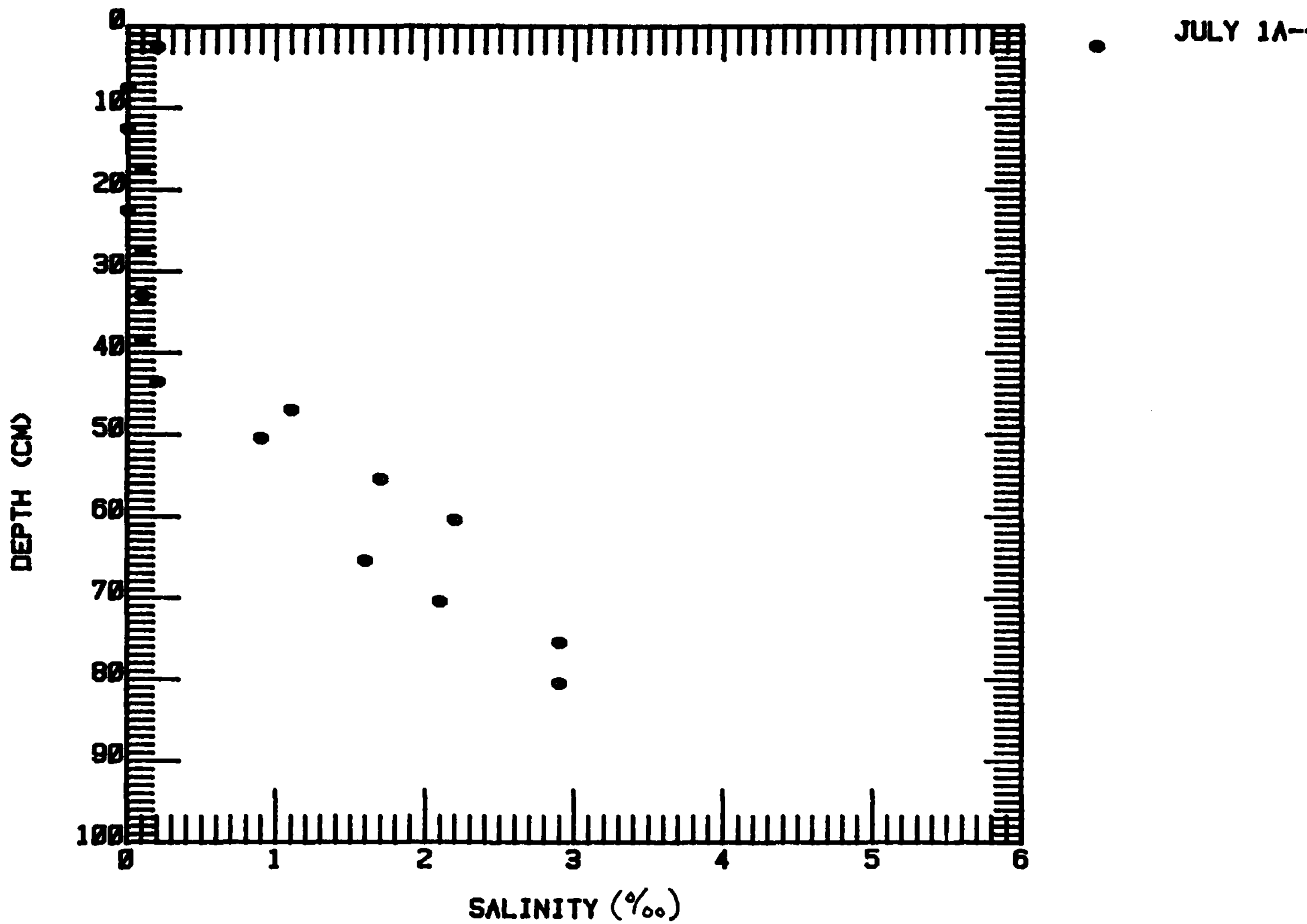


SALINITY MEASUREMENTS FOR MIZEX 1983

Salinity profile of multiyear ice (depth = 2.4 m) located at 81° 03.44N and 06° 06.47E at 1500 NST June 27. Core retrieved from an area of bare ice.

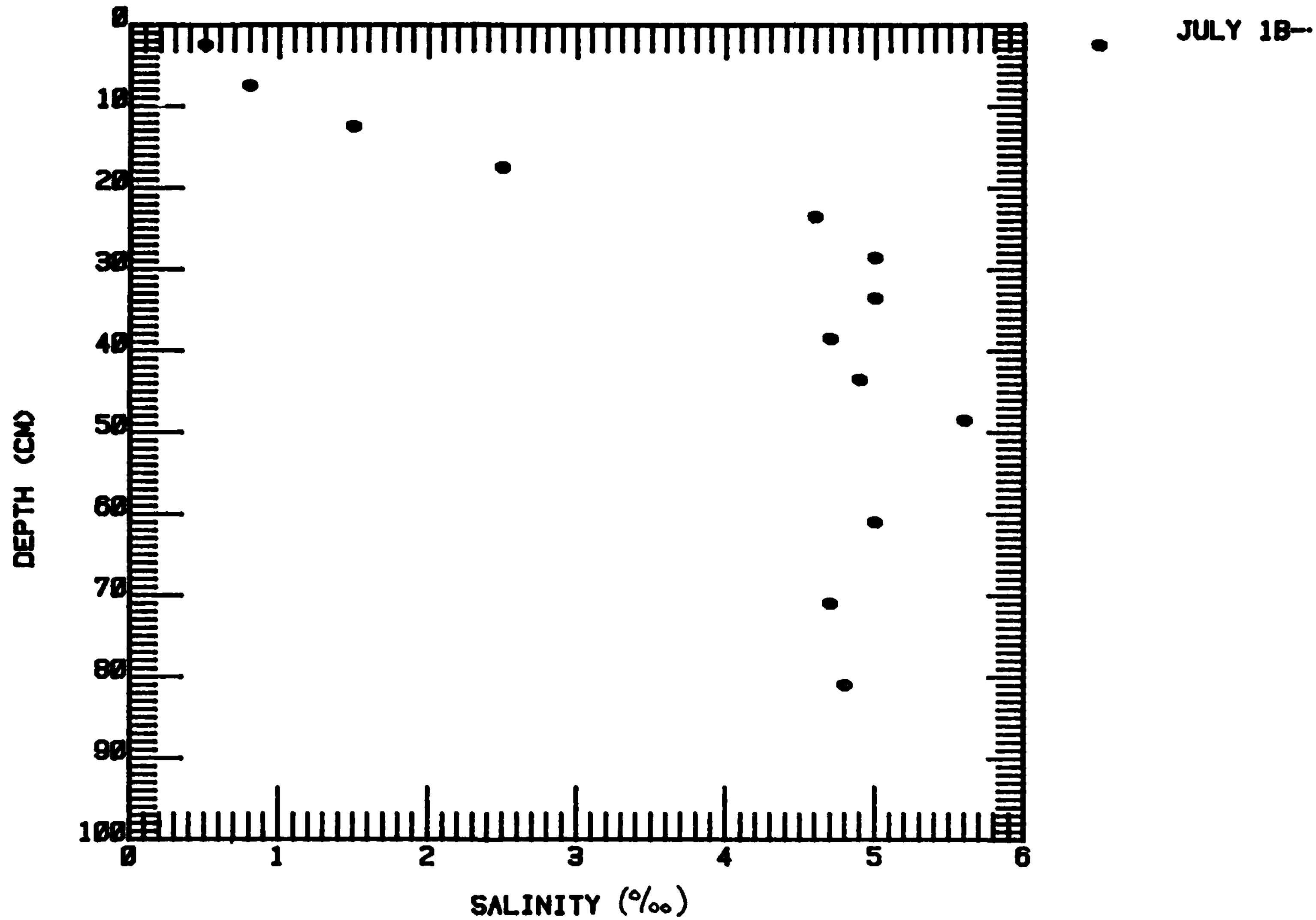


Salinity profile of multiyear ice (depth = 3.4 m) located at 81° 03.44N and 06° 06.47E at 1500 NST on June 27. Core retrieved from a snow-filled depressed area.



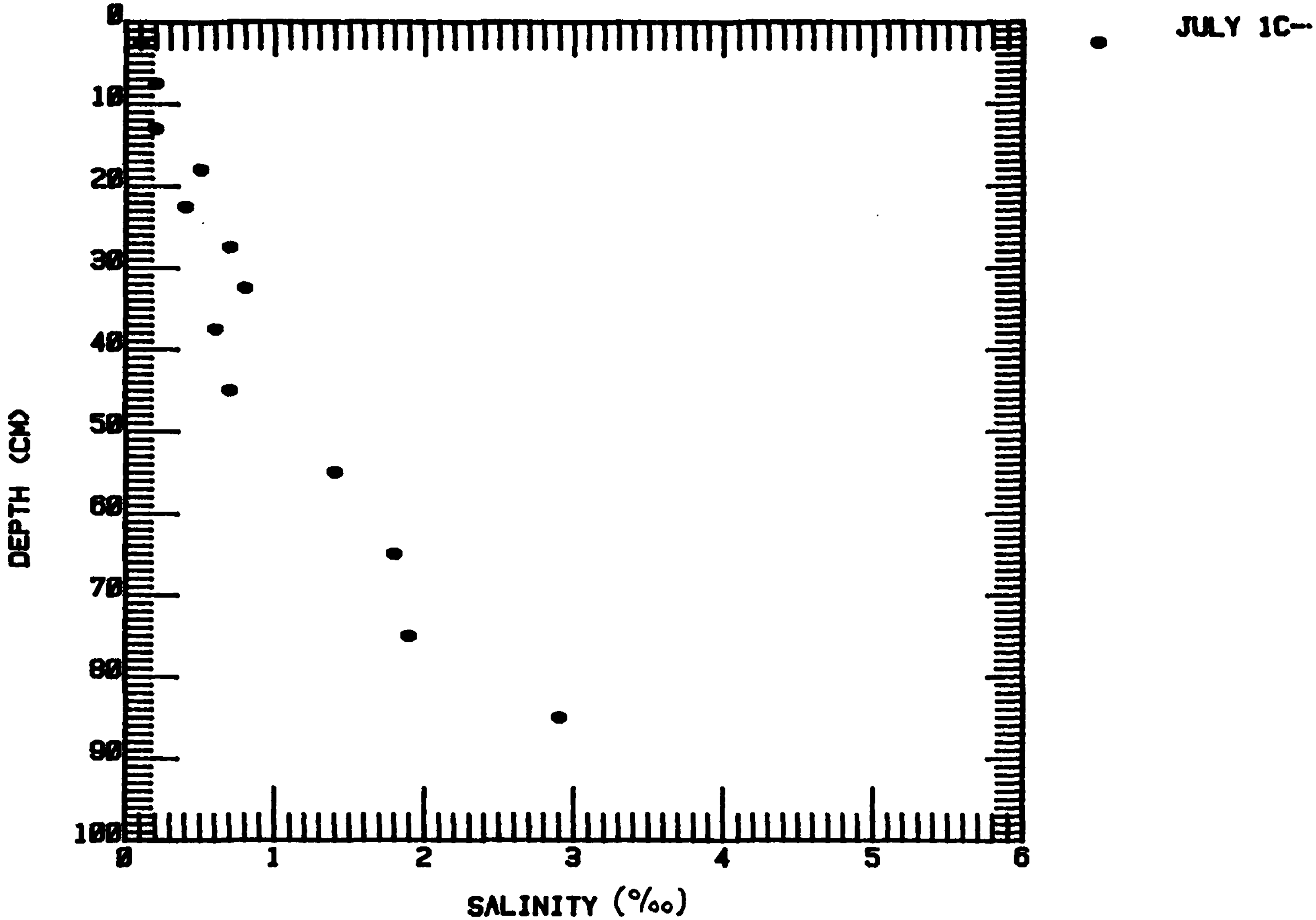
SALINITY MEASUREMENTS FOR MIZEX 1983

Salinity profile of multiyear ice (depth > 3 m) located at 81° 01.39N and 05° 47.78E at 1230 NST on July 1. Core retrieved from an area of snow free flat ice.



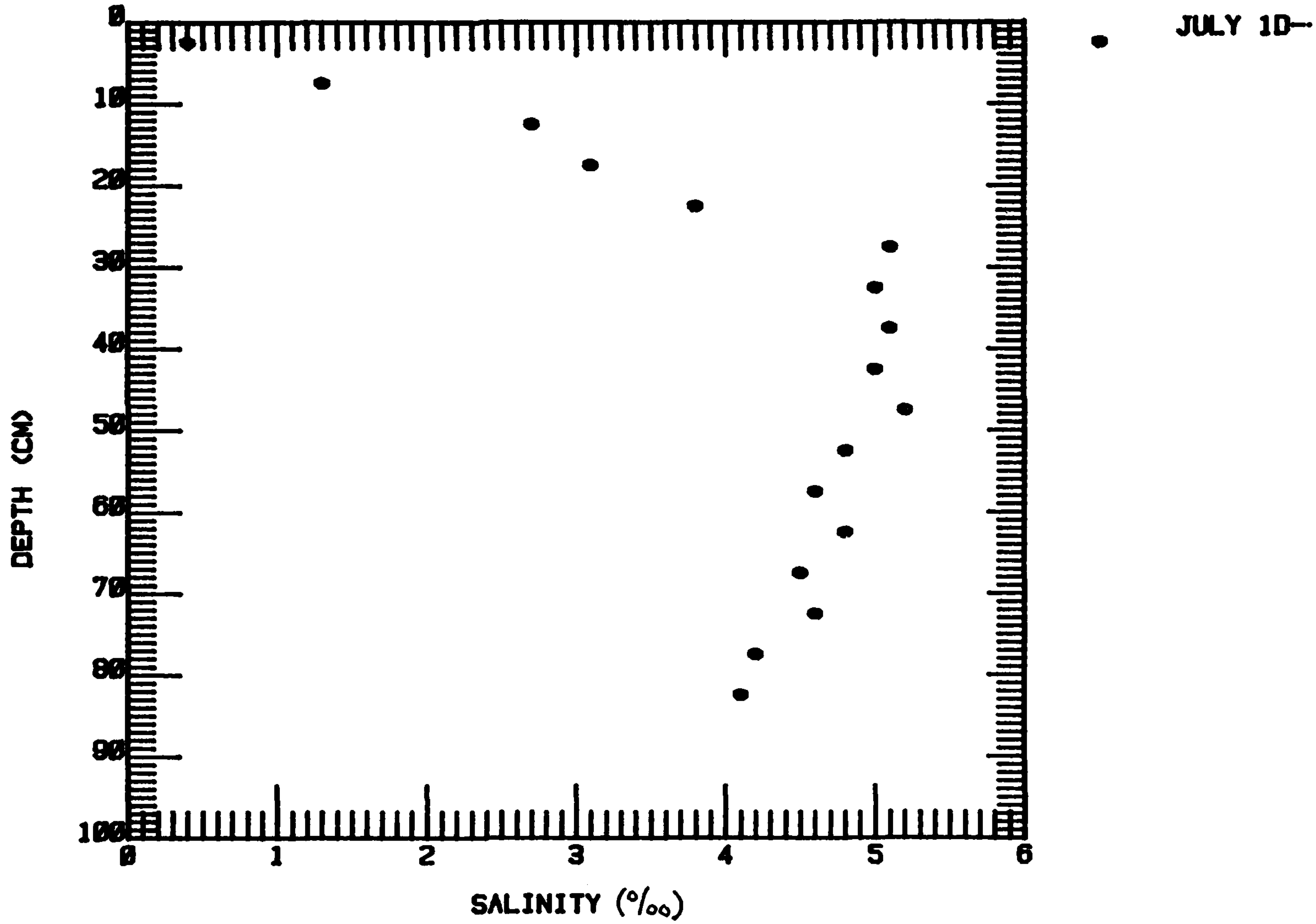
SALINITY MEASUREMENTS FOR MIZEX 1983

Salinity profile of thick first-year ice (depth = 1.8 m; free board = 3.5 cm) located adjacent to the Polarbjorn during the drift station at 1230 NST on July 1.

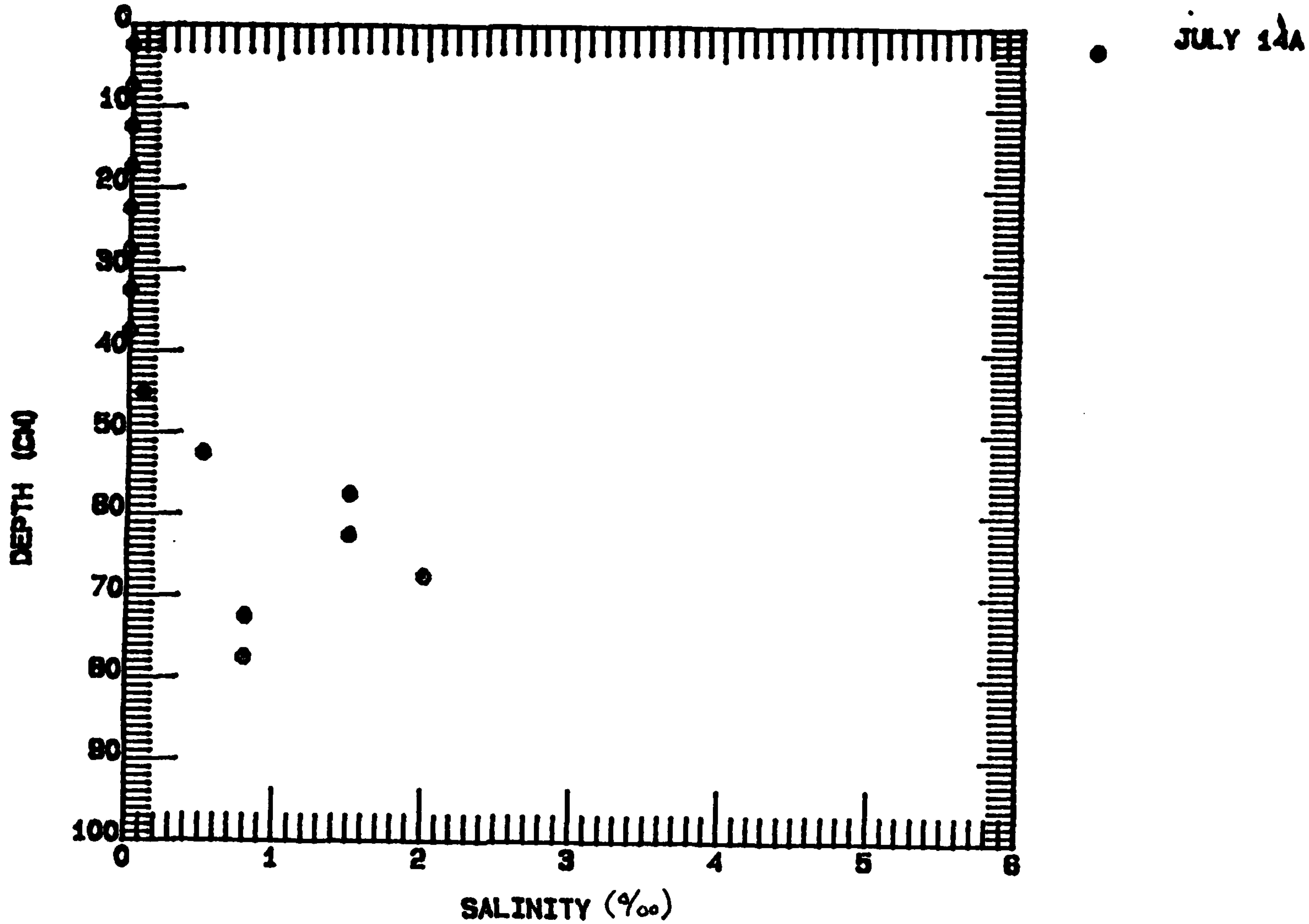


SALINITY MEASUREMENTS FOR MIZEX 1983

Salinity profile of thick first-year ice (depth = 1.9 m; free board = 25 cm) located adjacent to the Polarbjorn during the drift station at 1625 NST on July 1.

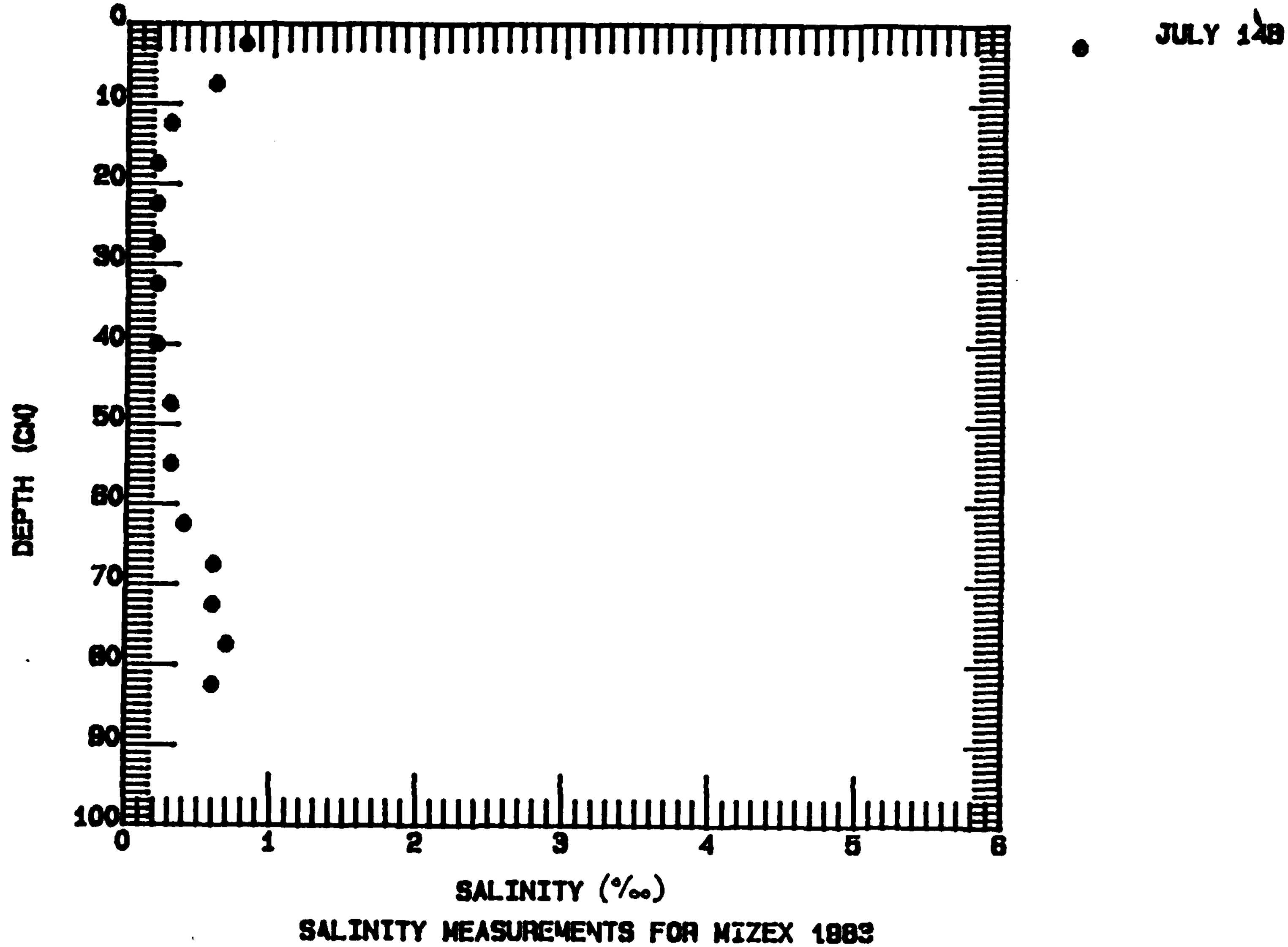


Salinity profile of first-year ice (depth = .64 m; free board = 7 cm) located adjacent to the Polarbjorn during the drift station at 1630 NST on July 1.

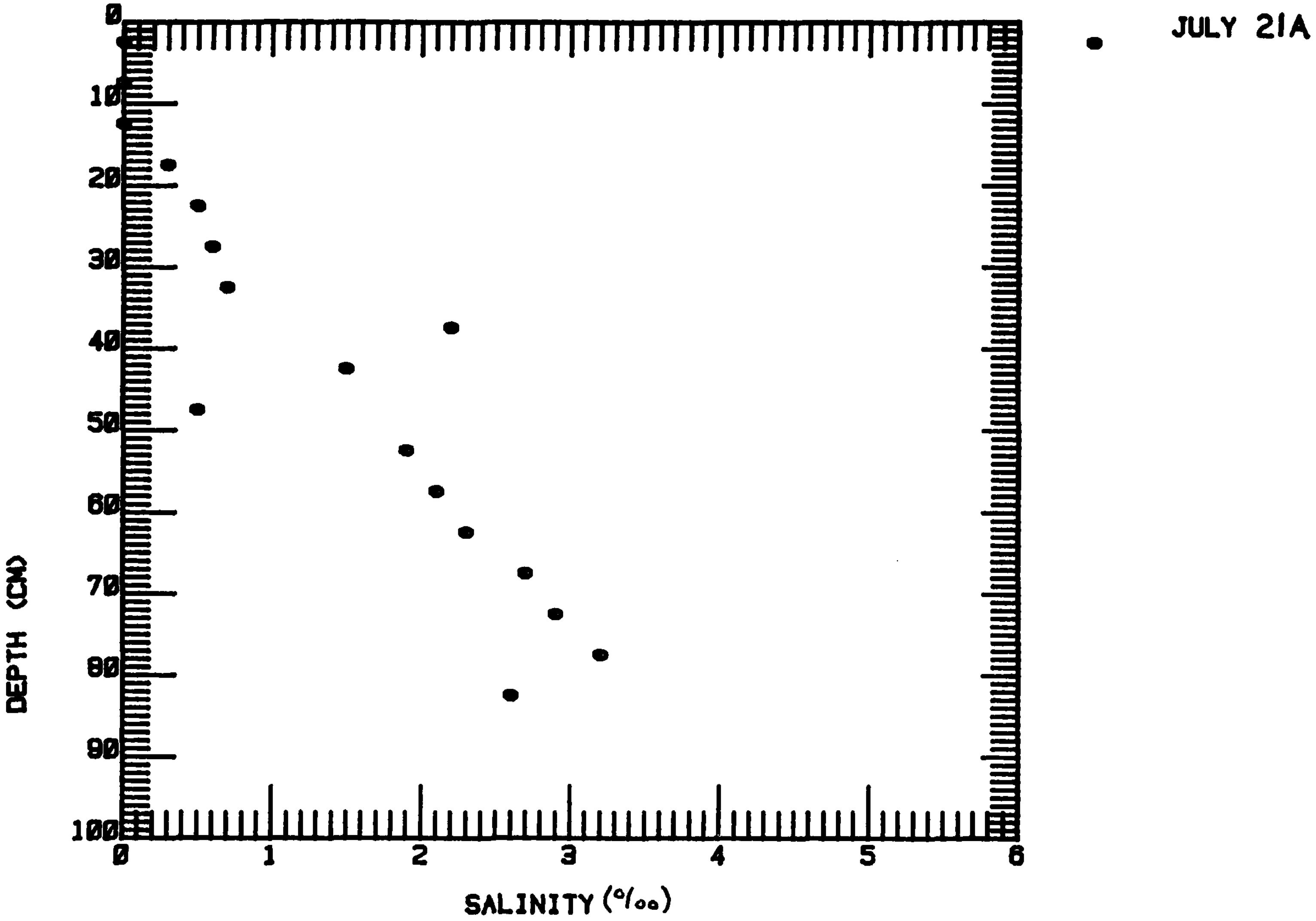


SALINITY MEASUREMENTS FOR MIZEX 1983

Salinity profile of multiyear ice (depth = 4.0 m; free board = 31.5 cm) located at 79° 19.59N and 01° 54.65E at 0930 GMT on July 14.

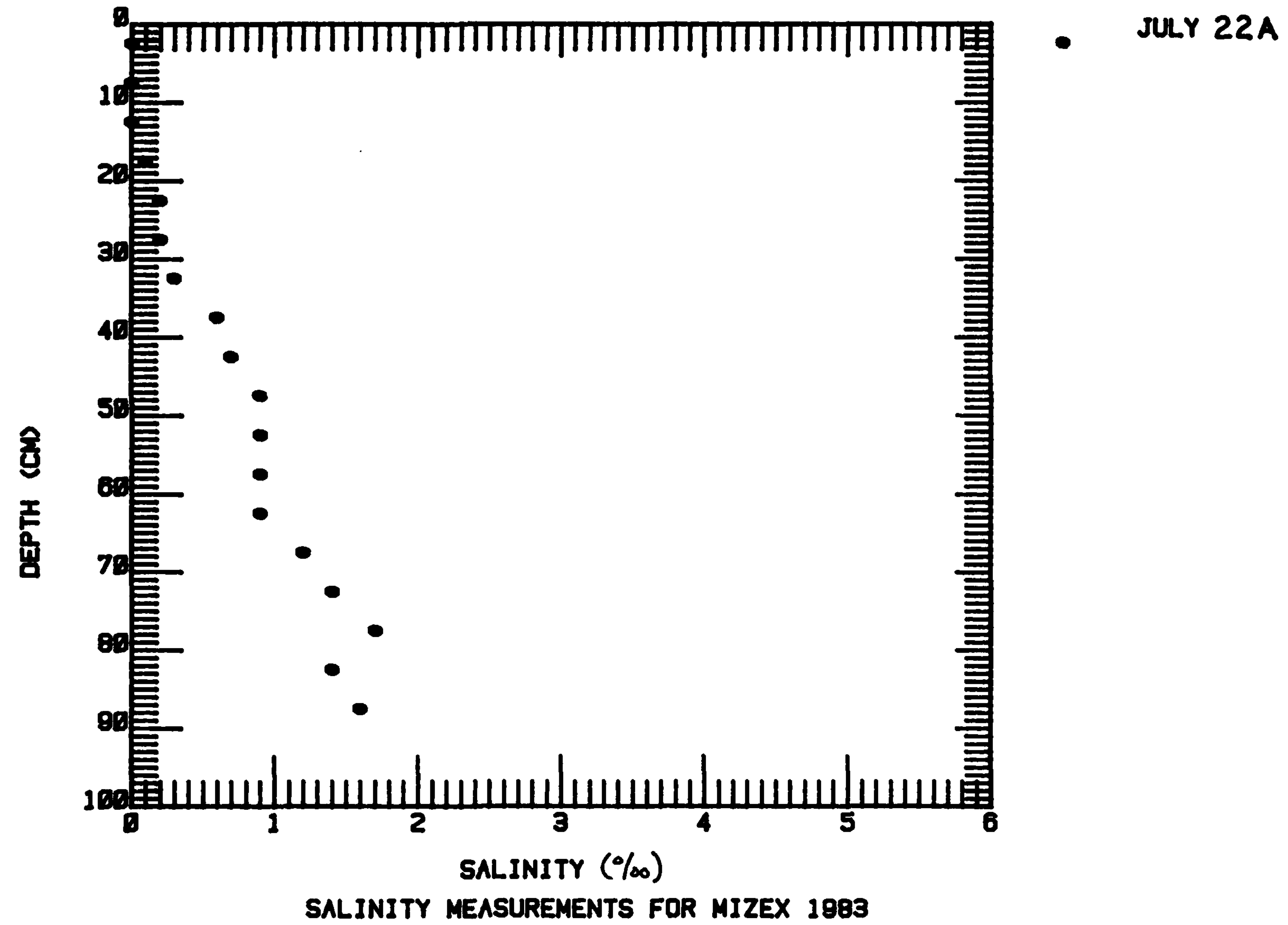


Salinity profile of thick first-year ice (depth = 1.79 m; free board = 25 cm) located at 79° 11.76N and 03° 05.26E at 0344 NST on July 15.



SALINITY MEASUREMENTS FOR MIZEX 1983

Salinity profile of thick first-year ice (depth = 2.40 m; free board = 18 cm) located at 78° 58.46'N and 1° 52.30W at 0700 NST on July 21.



Salinity profile of multiyear ice (depth = 3.15 m; free board = 18 cm) investigated at 1030 NST on July 22. Floe adjacent to floe investigated at 700 NST on July 21.

SALINITY PROFILE TABLES FOR ICE CHARACTERIZED DURING THE MIZEX SUMMER '83 CAMPAIGN

June 27-A
Multiyear

Depth-m	S-^{o}/oo
2.5	0.
7.5	0.
12.5	0.
17.5	0.
23.5	0.
29.5	0.1
34.5	0.1
40.5	0.7
46.5	2.5
51.5	1.4
56.3	0.7
61.5	1.1
71.5	1.4
76.5	1.4
81.5	1.9
86.3	2.1
91.5	2.4

June 27-B
Multiyear

Depth-m	S-^{o}/oo
2.5	0.0
7.5	0.0
12.5	0.0
17.5	0.0
22.5	0.0
27.5	0.0
32.5	0.0
37.5	0.0
42.5	0.2
47.5	0.4

July 1-A
Multiyear

Depth-m	S-^{o}/oo
2.5	0.2
7.5	0.
12.5	0.
17.5	0.1
22.5	0.
27.5	0.1
33.0	0.1
38.5	0.1
43.5	0.2
47.5	0.2
50.5	0.9
55.5	1.7
60.5	2.2
65.5	1.6
70.5	2.1
75.5	2.9
80.5	2.9

July 1-B
Thick First-Year

Depth-m	S-^{o}/oo
2.5	0.5
7.5	0.8
12.5	1.5
17.5	2.5
23.5	4.6
28.5	5.0
33.5	5.0
38.5	4.7
43.5	4.9
48.5	5.6
61.0	5.0
71.0	4.7
81.0	4.8

July 1-C Thick First Year	
Depth-m	S-°/oo
2.5	0.1
7.5	0.2
13.0	0.2
18.0	0.5
22.5	0.4
27.5	0.7
32.5	0.8
37.5	0.6
45.0	0.7
55.0	1.4
65.0	1.6
75.0	1.9
85.0	2.9

July 1-D Thick First Year	
Depth-m	S-°/oo
2.5	0.4
7.5	1.3
12.5	2.7
17.5	3.1
22.5	3.8
27.5	5.1
32.5	5.0
37.5	5.1
42.5	5.0
47.5	5.2
52.5	4.8
57.5	4.6
62.5	4.8
67.5	4.5
72.5	4.6
77.5	4.2
82.5	4.1

July 14-A Multiyear	
Depth-m	S-°/oo
2.5	-0.004
7.5	-0.006
12.5	-0.006
17.5	-0.003
22.5	-0.004
27.5	-0.004
32.5	-0.004
37.5	-0.003
45.0	0.116
52.5	0.530
57.5	1.469
62.5	1.461
67.5	1.956
72.5	0.844
77.5	0.770

July 14-B Thick First Year	
Depth-m	S-°/oo
2.5	0.786
7.5	0.631
12.5	0.307
17.5	0.233
22.5	0.241
27.5	0.179
32.5	0.189
40.0	0.196
47.0	0.274
55.0	0.336
62.5	0.360
67.5	0.608
72.5	0.626
77.5	0.693
82.5	0.635

July 21-A
Thick First Year

Depth-m	S-^{o}/oo
2.5	0.040
7.5	0.011
12.5	0.031
17.5	0.285
22.5	0.500
27.5	0.613
32.5	0.716
37.5	2.151
42.5	1.531
47.5	0.464
52.5	1.908
57.5	2.148
62.5	2.250
67.5	2.733
72.5	2.914
77.5	3.213
82.5	2.580

July 22-B
Thick First Year

Depth-m	S-^{o}/oo
2.5	0.028
7.5	0.011
12.5	0.021
17.5	0.086
22.5	0.157
27.5	0.227
32.5	0.267
37.5	0.559
42.5	0.714
47.5	0.856
52.5	0.942
57.5	0.881
26.5	0.944
67.5	1.245
72.5	1.377
77.5	1.718
82.5	1.391
87.5	1.574
92.5	1.790
97.5	2.040

PART II:

HELICOPTER-BORNE AND SHIP-BASED RADAR BACKSCATTER MEASUREMENT OF SEA ICE IN THE MARGINAL ICE ZONE

ABSTRACT

Measurements were made as part of the MIZEX-83 Program of the radar backscatter from sea ice during the summer melt period in the marginal ice zone between East Greenland and Spitzbergen. Data were acquired using a helicopter-borne scatterometer (HELOSCAT) at frequencies between 4 and 18 GHz, at angles from 10° to 60° from vertical, and with like- and cross-antenna polarizations. A ship-based version (SHIPSCAT) operated using similar radar parameters, but with angles from 15° to 83°. These measurements were also supported by sensor-oriented ice characterization measurements. The objective was to make descriptions of the scattering coefficients of the major ice types in the region and to study the influence of summer melt on ice conditions and the radar response. These observations are also important in better understanding the microwave radiation process with ice. Details of this experiment are described herein.

Analysis of the results shows the following:

There were three basic ice types: first-year, thick first-year and multiyear. Floes often exhibited some deformation. Thick first-year and multiyear floes were typically covered by a thick (to the radar) layer of moist (often saturated) snow. Ice features covered by thick layers of snow ere masked and exhibited low backscatter. Areas which were composed of firn or other ice features produced higher levels of backscatter. These ice types are difficult to discriminate due to the presence of the wet snow layer.

The other major ice type, first-year, did not have a snow cover, but a 2-cm crust composed of vertical ice crystal growths topped with a membrane-like ice layer. First-year ice provided about 2 dB more

backscatter than that from the thicker ice. Both backscatter levels and physical properties of the snow were also found to be influenced by diurnal effects. The freezing of the upper 3 cm of the snow layer enhanced backscatter return from snow-covered ice.

INTRODUCTION

Radar backscatter measurements of sea ice and ocean were made at multiple locations at the Greenland Sea ice edge in the region north and west of Spitzbergen in participation in the Marginal Ice Zone Experiment June and July 1983 Campaign. These measurements were also supported by sensor-oriented ice characterizations made by the University of Kansas. The objective of our participation was to make descriptions of the scattering coefficients of the major ice types that are present in the region and to study the influence of summer melt on ice conditions and the radar response. These observations are also important in better understanding the microwave radiation process with ice, snow and oceans. These data will provide quantitative indications of the ability to measure the difference between different categories of ice during the summer months and provide an indication of the ambiguities in the ability to discriminate ice conditions which may be uniquely characteristic of this region. The description of the scattering properties of ice in the margin as well as the ice characterizations will be used to support and validate the remote sensing data obtained from the aircraft platforms, CV-580 and NRL-P3.

THE RADAR REMOTE SENSOR

The sensor used in this experiment program was a multi-frequency, multi-polarization, and multi-angle-of-incidence frequency-modulated continuous-wave (FM-CW) calibrated radar (scatterometer). The frequency range included C-band (4-8 GHz), X-band (8-12 GHz), and Ku-band (12-18 GHz) (see Table 1 for system specifications). Polarization capabilities included HH, VV, and HV (H = horizontal, V = vertical; the first letter identifies transmitted polarization and the second identifies received polarization). The radar was flown using a Bell Model 206B helicopter (with inflatable floats) at an altitude from 15 to 30 meters with the antennas mounted so that the radar was side-looking and could operate at angles from 10° to 60° from vertical. During ship operation the radar was mounted on the wheelhouse deck of the Polarbjorn ice-strengthened ship, also in a side-looking mode and at a location near the bow of the ship which relieved problems associated with the effects of bow thrusting. Scenes could be viewed at angles from 15° to 83°.

Internal calibration necessary for short-term variations in the radar was accomplished by passing the radar signal through a delay line of known loss. Overall system calibration was performed by measuring the backscatter from a Luneberg lens which was a target of known radar cross-section.

EXPERIMENT DESCRIPTION

During the periods from June 21 to July 2, July 8 to July 10, and July 17 to July 22, sea ice and ocean were investigated using the ship-mounted scatterometer. Data were acquired in two modes: (a) with the ship at station and moored to a floe, and (b) with the ship traversing

the ice. At station, a floe was scanned from 15° to 83° in increments of 2° - 5°, at various frequencies and like- and cross-antenna polarizations. In the transect mode, the angle was fixed at 40°, the polarization at HH, and the prime frequencies at either 5.2, 9.6, 13.6 and 16.6 GHz. During the drift phase of the experiment, the Polarbjorn was moored to a floe of multiyear ice and it was under continual examination from June 28 to July 2. These data should assist in the study of the influence of the diurnal and melt cycles on the microwave response of ice. On July 18 and 19, backscatter data were acquired to examine a sea surface temperature gradient. During the ice edge phase of the experiment, sea ice conditions in the western region were investigated. Floes located in this region were seen in a state of melt characteristic of that found much earlier in the experiment in the eastern region.

On July 3, 5, 6 and 11, the helicopter-borne scatterometer was in operation and examined representative ice types which were present in the region about the drift station where measurements had been made for characterization studies: a very large composite of multiyear, thick first-year and first-year ice which was located 12 nautical miles almost directly to the north of the drift station; and ice and ocean in the region near the leading edge of the zone near the Polarstern on July 11. The HELOSCAT made measurements in a profiling mode and also in scans in which multiple angles were used to examine representative ice types.

A summary of backscatter measurements is included in Table 2. Floes that were investigated have been identified with geographical locations and time of observation. Characterization measurements began

June 22 and extended through to July 26. Ice sheets were classified according to type, thickness, salinity, average snow depth, physical properties of the snowpack, and the state of melt. These data have been included in a University of Kansas report which specifically details these measurements.

TABLE 1
HELOSCAT III SYSTEM SPECIFICATIONS

Type	FM-CW
Frequency Range	4-18 GHz
Modulating Waveform	Triangular
FM Sweep	800 MHz
Transmitter Power	14-19 dBm
Intermediate Frequency	50 kHz
IF Bandwidth	13.5 kHz
Antennas:	Log-Periodic Feed Reflectors
No. 1	
Size	46 cm
Polarization	VV
Beamwidths (β_e)	7.6°, 4.9°, 3.7° and 2.9° at 4.8, 7.2, 9.6 and 13.6 GHz
No. 2	
Size	61 cm
Polarization	HH
Beamwidths (β_e)	5.4°, 3.7°, 2.7° and 1.9° at 4.8, 7.2, 9.6 and 13.6 GHz
No. 1/2	
Size	64 cm and 61 cm
Polarization	Cross
Beamwidths (β_e)	6.3°, 4.2°, 3.2° and 2.3° at 4.8, 7.2, 9.6 and 13.6 GHz
Incidence Angles	10° to 70° from nadir
Calibration:	
Internal	Signal Injection (delay line)
External	Luneberg lens
Altitude	30 m for θ = 10° to 50° 15 m for θ = 60° and 70°

TABLE 2

SUMMARY OF UNIVERSITY OF KANSAS/RSL
DATA EVENTS DURING MIZEX-83

Date/Site	Sensor Mode	OP Mode	Freq.	Pol.	θ	Scene Type (Depth-Snow) m cm	T_{AIR} -°C-	Location	Photo
June 21-A	S	P	5,13	H	40	Edge		T = 1655 NST	
June 22-A	S	P	CXK	VHX	40	Smooth Ocean			
-B	S	θ	CXK	VHX	35-40	FY (1.4-20)	0.6		
June 24-A	S	P	5	H	40	Edge		T = 1238 NST	
-B	S	θ	5	VHX	20-75	TFY (2.0-50)		80° 38.60'N 04 08.20E	X
-C	S	P	9	H	40	Rubble		80° 52.26N 05 33.53E	
-D	S	θ	CXK	VHX	25-75	FY (~1-0)	0.0	80° 43.68N 14 45.34E	X
June 25-A	S	P	5,9	H	40	FY (≈1-30)	0.7	80° 51.46N 05 25.86E	
-B	S	θ	CXK	VHX	20-70	TFY (?-40)	1.2	80° 52.26N 05 33.53E	X
June 26-A	S	θ	CXK	VHX	15-70	FY (def-50)	2.8	81° 04.59N 05 29.22E	X
June 27-A	S	P	9,13	H	40	Edge	-0.4		
-B	S	θ	CXK	H	20-70	MY (>4-25)	-0.4	81° 03.44N 06 06.47E	X
-C	S	θ	CXK	H	20-70	FY (1.5-?)			
June 28-A	S	θ	CXK	VHX	15-80	Drift Station	0.0	81° 01.39N 05 47.78E	X
June 29-A	S	θ	CXK	VHX	20-80	MY (>4-≈20)	-1.8	T = 1330 NST	X
-B	S	θ	CXK	VHX	20-35	MY (>4-≈20)	-0.5	T = 1549 NST	X
-C	S	θ	CXK	VHX	20-80	MY (>4-≈20)	-0.1	T = 2017 NST	X
June 30-A	S	θ	CXK	H	15-83	MY (>4-≈20)	+1.0	T = 1549 NST	X
July 01-A	S	θ	CXK	H	14-74	MY (>4-≈20)	-0.5	T = 1330 NST	X
July 02-A	S	θ	CXK	H	15-78	MY (>4-≈20)	+1.0	T = 0900 NST	X
July 03-A	H	P	9	VHX	35	12 Mile Floe		T = 2439 NST	
July 05-A	H	P	CXK	H	40,50	Drift Station FL	0.0	T = 0200 NST	
-B	H	P	5	H	40	FY, TFY, MY	0.0	T = 0200 NST	X
July 06-A	H	θ	CXK	H	10-60	12 Mile Floe	1.5	81° 32.00N 06 51.2E	X
-B	H	P	5,9	H	40	Edge	1.5		
-C	H	P	5,9	H	40	Drift Station FL	1.5		
July 08-A	S	θ	CXK	VHX	40-65	TFY	0.3	T = 1506 NST	
-B	S	P	5,9	H	40	Edge	0.3		
July 09-A	S	θ	CXK	H	18-74	TFY (1½-?)		T = 2220 NST	X
July 10-A	S	P	9	H	40	Edge		T = 0307 NST	
July 11-A	H	P	CXK	V	35	North-South FL		79° 41.82N 02 02.16E	
-B	H	P	CXK	V	35	East-West FL		79° 41.82N 02 02.16E	
-C	H	P	CXK	V	40	MY, TFY, FY		79° 41.82N 02 02.16E	X
July 17-A	S	P	5,9	V	40	Edge		79° 07.97N 02 13.62E	
July 18-A	S	P	5,9,13	V	50°	Ocean Transect		T = 1859-2301 NST	
July 19-A	S	P	5,9	V	40	Ocean		78° 53.85N 03 00.75E	
-B	S	θ	CXK	VH	20-75	TFY	-0.6	78° 54.06N 03 01.93E	X
July 20-A	S	θ	CXK	VHX	20-75	TFY (1½-30)	0.0	78° 58.46N 01 52.30W	X
July 21-A	S	θ	CXK	VHX	20-75	TFY (24-25)	0.3	78° 58.46N 01 52.30W	X
July 22-A	S	θ	CXK	VHX	20-75	MY (3.2-4)	0.9	T = 1031 NST	X

LEGEND:

Sensor Mode: S = SHIPSCAT H = HELOSCAT
Operation MOde: P = Profiles θ = Angular Response
Freq: CXK = 5.2, 9.6, 13.6 and 16.6 GHz
5 = 5.2 GHz
9 = 9.6 GHz
13 = 13.6 GHz
Pol: V = VV; H = HH; X = Cross

END

FILMED

5-84

DTIC